United States Patent and Trademark Office

Examiner: Jeffrey R. W   Art Unit: 2857   Docket No. 3804

In re:

Applicant: Tobias Lang

Serial No.: 10/591,897

Filed: September 7, 2006

REPLY BRIEF

October 6, 2010

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sirs:

Appellant submits the following REPLY BRIEF in Response to the Examiner's Answer, mailed August 9, 2010.

XI. <u>ARGUMENT IN REPLY TO EXAMINER'S ANSWER</u>

1. Appellant's Reply to Examiner's "(10) Response to Argument" with respect to the rejection of claims 1 and 4-7 under 35 USC §112, second paragraph

The Examiner's Answer ("the Answer") asserts that claims 1 and 7 are "vague and indefinite" under 35 USC §112, second paragraph, for two reasons.

<u>First.</u> At page 15 of the Answer, the Examiner presents three points to support the first position.

I.) The Examiner asserts that while claims are interpreted in light of the specification, limitations from the specification are not read into the claims (citing <u>In re van Geuns</u>, 988 F. 2d 1181, 26 USPQ 1057 (Fed. Cir. 1983)), that there is nothing in the claims that defines the variable A(K) as "the amplitude of the K^{th} half-wave, after the threshold (trigger time) is exceeded" (italics included the Answer).

II.) The Examiner asserts that if one having ordinary skill in the art would assume A(K) to be "the amplitude of the K^{th} half-wave, after the threshold (trigger time) is exceeded," such an assumption would raise an issue of indefiniteness under 35 USC 112, second paragraph, as it would be unclear to one having ordinary skill in the art as to what the "the Kth half wave" and/or "the threshold (trigger time)" refers to, since there is nothing in the claim that presents such a "K^{th} half wave" or "threshold (trigger time)."

III.) The Examiner asserts that it would be unclear to one of ordinary skill in the art whether of not the "K^{th} half-wave" somehow refers/relates to the previously presented "ultrasonic signal" and/or whether or not "the threshold (trigger time)" somehow refers/relates to the previously presented times "t_0" or "t_1."

<u>Second.</u> At page 16 of the Answer, the Examiner sets forth claim 1, explaining that the claim presents "<u>ultrasonic signals</u>," "<u>a predetermined event (N) of an ultrasonic signal as a reception time (t_0),</u>" "<u>a time (t_1) of a characteristic value of the ultrasonic signal</u>" and "<u>the ultrasonic signal or its envelope curve</u>" (italics included in the Answer; underlining added by appellant).

The Examiner then asserts that without defining "A" in the claim, it is unclear to one having skill in the art how the equation is used in the remainder of the claim, for example, whether or not the index counter K is to somehow correspond/relate to the predetermined event (N) or to one of the reception time (t_0) or to the time (t_1), as well as whether or not the variable "A(K)" is to somehow correspond/relate to the amplitude of the predetermined even, the amplitude of the characteristic value, the amplitude of the ultrasound signal and/or the amplitude of the envelope curve, and that the undefined variable "A" makes claims 1 and 7, and consequently claims 4-6 due to their dependency, unclear under 35 USC 112, second paragraph.

Appellant respectfully disagrees with the Examiner's First and Second arguments, as follows.

First. Appellant agrees that to determine whether claims are definite, the claims should be read in light of the Specification, and that limitations from the specification should not be read into the claims.

Appellant respectfully disagrees, however, that any limitation from the specification is required to be read into the claims as written to ensure that their scope is clear and definite.

Claims 1 and 7 set forth an ultrasonic flow sensor and method.

Claim 1, for example, sets forth

an ultrasonic flow sensor, comprising at least one ultrasonic transducer for transmitting and receiving "ultrasonic signals," and a receiver unit (4) connected to the at least one ultrasonic transducer that detects "a predetermined event (N) of an ultrasonic signal as a reception time (t_0),"

wherein the receiver unit (4) determines "a time (t_1) of a characteristic value of the ultrasonic signal" as well as a time shift (Δt) of the time (t_1) relative to the reception time (t_0) and

uses the time shift (Δt) to determine a correct time value for the reception time (t_0), wherein the receiver unit (4) determines a chronological position (T_s) of a focal point of either "the ultrasonic signal or its envelope curve" (6) as the characteristic value, wherein

$$Ts \sim \left(\sum_{K=1}^{n} K * A(K) \right) / \sum_{K=1}^{n} A(K) .$$

In both claims, a receiver unit detects a reception time (t_0) of an ultrasonic signal, a time (t_1) of a characteristic value of the signal and a time shift (Δt) of the time (t_1) relative to the reception time (t_0).

The time shift (Δt) of the time (t_1) of the characteristic value relative to the reception time (t_0) is used by the receiver unit to determine a correct time value for the reception time (t_0).

The essence of the invention is its capability of using the relative time shift (Δt) to determine a correct time value for the reception time (t_0).

The receiver unit determines a chronological position (Ts) of a focal point of either the ultrasound signal or its envelope curve as the characteristic value.

The last clause of the claim, a "wherein" clause, sets forth out an equation that is used by the receiver unit to calculate the chronological position Ts, which includes an undefined variable A(K).

A(K) is defined in the specification at page 4, lines 16-17, as follows: A(K) is the amplitude of the K^{th} half-wave after the threshold (trigger time) is exceeded.

The Examiner does not assert that claims 1 and 7, if read in light of the Specification, are vague and indefinite, or that the claims are vague and indefinite without reading a limitation into the claims that is found in the specification but not found in the claims.

I.) More particularly with respect to the Examiner's point **I.)**, Appellant respectfully asserts that A(K) is not a limitation which must be "read into" claims 1 and 7 to render them clear and definite to the skilled artisan, as A(K) is present in the claim. The chronological position Ts is calculated using A(K) by the receiver unit, but it is not necessary to define A(K) directly in the claim language to enable the skilled artisan to understand the chronological position Ts, and how it relates

to the relative time shift (Δt) for determining a correct time value for the reception time (t_0).

Appellant has never argued or attempted to distinguish the scope of the claims from the prior art by the use of A(K) in any of the responses to final and non-final Office Actions, or in response to the Examiner's Answer herein.

MPEP 707.07(f) advises that an Examiner should utilize paragraph 7.37.08 to respond to an applicant's response to a rejection asserted in an Office Action under 35 USC §112, second paragraph, wherein the applicant's Office Action Response argues features not found in the claims:

> **7.37.08 Unpersuasive Argument: Arguing Limitations Which Are Not Claimed**
> In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., **[1]**) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See In re Van Geuns, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Applicant has not argued a feature (i.e., A(K)) that is not found in the claims. Put another way, while A(K) is an undefined variable within claims 1 and 7, undefined variables included in a claim but defined in the Specification do not render the claims vague and indefinite under the law.

For that matter, the issue of an undefined variable included in an equation within a claim is addressed in slide 37 of a power point slide presentation on **35 U.S.C. 112 2nd** paragraph, prepared by Julie Burke, Training Quality Assurance Specialist at the United Sates Patent and Trademark Office (TC 1600 QAS). Slide 37 of Training Quality Assurance Specialist Burke. The first and 37th slide of Examiner Burke's presentation are appended to this REPLY BRIEF as

Attachment A. Slide 37 clearly evidences that an undefined variable included in an equation within a claim is not grounds for a rejection under section 112, second paragraph, if the variable is defined in the specification, as is the instant case.

The MPEP 2173.02 makes clear that the essential inquiry pertaining to this requirement of precision and clarity under 35 USC §112, second paragraph is whether the claims set out and circumscribe a particular subject matter with a reasonable degree of clarity and particularity. Definiteness of claim language must be analyzed, not in a vacuum, but in light of:

(A) The content of the particular application disclosure;

(B) The teachings of the prior art; and

(C) The claim interpretation that would be given by one possessing the ordinary level of skill in the pertinent art at the time the invention was made.

A recent Board of Appeals precedential opinion addresses the issue of reading claims narrowly in view of ambiguity, post-issuance, in contrast to the giving them the broadest possible interpretation during prosecution. Ex parte Miyazaki, Appeal No. 2007-3300 (BPAI 2008).

Miyazaki at page 10, first full paragraph, states that "unlike in post-issuance claim construction, the USPTO gives pending claims 'their broadest reasonable interpretation consistent with the specification' and 'in light of the specification as it would be interpreted by one of ordinary skill in the art.'" There is no ambiguity at issue in the instant case. A(K), given the broadest reasonable interpretation consistent with the specification' is the amplitude of the K^{th} half-

wave after the threshold (trigger time) is exceeded. None of the other claim limitations rely on A(K) to render clear and definite their meanings or scope within the claims as a whole.

II.) More particularly with respect to the Examiner's point II.), appellant respectfully asserts that the law requires the skilled artisan to interpret the scope of the claim as a whole by reading or defining A(K) in its broadest reasonable interpretation consistent with the specification, which defines A(K) as the amplitude of the K^{th} half-wave after the threshold (trigger time) is exceeded (the Specification at page 4 lines 16-17).

It should be noted that the Examiner agrees in the Answer at page 15 that one skilled in the art would recognize that "K" corresponds to an integer index.

While A(K) is defined in the specification at page 4, lines 16-17, as follows: A(K) is the amplitude of the K^{th} half-wave after the threshold (trigger time) is exceeded, and A(K) is not specifically define in the claims, exactly what A(K) is or does in the equation for Ts is not necessary, when read in light of the specification, to understand that the characteristic value is the chronological position (Ts) of a focal point of either the ultrasound signal or its envelope curve as the characteristic value, and that the time shift (Δt) of the time (t_1) of the characteristic value relative to the reception time (t_0) is used by the receiver unit to determine a correct time value for the reception time (t_0), which is the essence of the invention as claimed.

III.) More particularly with respect to the Examiner's point III.), appellant respectfully asserts that by interpreting claims 1 and 7 in light of the Specification, including A(K) in the equation for the chronological position Ts, the skilled artisan would clearly understand the scope of the claimed subject matter, whether and how the K^{th} half-wave relates to the presented ultrasonic signal, and whether or not the threshold (trigger time) relates to the previously presented times t_0 or t_1.; <u>Miyazaki</u> at page 10.

For that matter, the final rejection of claims 1 and 4-7 under 35 USC §112, second paragraph, does not assert that it would be unclear whether the K^{th} half-wave relates to the ultrasonic signal, and/or whether or not the threshold (trigger time) relates to the previously presented times t_0 or t_1.

The final rejection merely asserts that claims 1 and 7 include an equation for the chronological position Ts, and that the equation for Ts includes undefined variables "K" and "A", making it unclear what the equation defines and how the equation is used in the remainder or the claim.

<u>Second.</u> While the Examiner asserts that without defining the variable "A" within the equation for Ts, one skilled in the art would not understand how to use the equation for Ts in the remainder of the claim, appellant respectfully asserts that the equation for Ts is the last element in the claim, that because A(K) is included in the claim, because A(K) is clearly defined in the specification at page 4, lines 16-17 and because the test for definiteness under section 112, second

paragraph, is whether the skilled artisan, when reading the claim with the particular limitation in light of the Specification would understand its scope.

For that matter, and with all due respect, the Examiner essentially agreed that the equation is readily understood in the Interview Summary mailed August 28, 2009, where he stated that

"a provisional agreement was reached that the combination of Eshita and Katakura does not teach determining a focal point if defined by the equation on page 4, line 13 of the specification."

The Examiner essentially interpreted the scope of the claim in light of the Specification, and found it sufficiently clear and definite to distinguish prior art, so that even with variable A(K) defined not in the claim itself but in the Specification at page 4, lines 16-17, one skilled in the art, in light of the specification, would understand how A(K) is used in equation Ts with the remainder of claims 1 and 7, and that claims 1 and 7 are neither vague nor indefinite under 35 USC §112, second paragraph.

2. Appellants Reply to the Examiner's "(10) Response to Argument" with respect to the rejection claims 1, 4, 6 and 7 under §103(a) over Eshita in view of Ai.

Appellant respectfully disagrees that claims 1, 4, 6 and 7 are obvious under §103(a) over Eshita in view of Ai.

Before addressing the rejections over Eshita in view of Ai, however, appellant requests that the Board give the arguments presented in this REPLY

BRIEF to overcome the art rejections over Eshita greater weight than the arguments presented in his APPEAL BRIEF, filed on May 24, 2010.

Appellant makes the request in view of the fact that appellants now realize, with hindsight, that they were not provided a copy of the full translation of Eshita until October 4, 2010, which the Examiner had since at least March, 2009 and used to support his position presented in two Office Actions and an advisory Action.

That is, appellant was provided a copy of an 8-page translation of Eshita, with a single figure, with the non-final Office Action mailed on June 25, 2007, where the Examiner received a new, much fuller and more clear translation (at about 24 pages approximately three times the length and breadth of the 8-page translation.

A copy of this 8-page Eshita translation (supplied on June 25, 2007), found at pages 303-310 of the PAIR file history (downloaded October 3, 2010), is appended hereto as Attachment B.

A copy of the 24-page translation (supplied on October 4, 2010), including drawing figures, identified on the first page by title and as a translation from 2009 by Schreiber Translations, Inc., is appended hereto as Attachment C.

While before the March 19, 2009 Office Action the Examiner referred to the pages and line numbers in the 8-page Eshita translation, the Examiner began referring to the whole paragraph, as well as the numbers of lines in each whole paragraph, as shown in the full 24 page Eshita translation as of March 19, 2009.

For that matter, the Examiner has copied the whole of paragraphs [0014] (12 lines), [0026] (16 lines), [0030] (6 lines) and [0032] (13 lines) into the Answer (and new Fig. 2).

Paragraphs [0014], [0026], [0030] and [0032] of the 8-page Eshita translation comprise 8 lines, 10 lines, 4 lines and 8 lines respective, and is practically incomprehensible.

A quick comparison of the paragraphs [0014], [0026], [0030] and [0032] of the 8-page Eshita translation with the same numbered paragraphs of the 24-page Eshita translation shows that the 8-page translation is all but indecipherable and incomprehensible.

Appellant nevertheless used same to respond to the non-final Office Action mailed March 19, 2009, the final Office Action mailed November 27, 2009 and the Advisory Action mailed February 27, 2010. Again, the Examiner was in possession of the 24 page Eshita translation since at least as early as March 19, 2009, but inadvertently failed provide a copy to appellant or make same available in the electronic file wrapper though PAIR.

Turning now to the substance of the rejections, the Examiner asserts at page 19 of the Answer that Eshita discloses that its receiver unit determines a time (t_1) of a characteristic value of the ultrasonic signal (paragraph [0026], lines 1-16) by determining a zero-crossing time Z of the characteristic value Wm, that is, that Wm is the characteristic value.

Appellant respectfully disagrees.

Paragraph [0026] of the 24 page Eshita translation teaches calculating a reception time of a received wave W using a counter 12 and a gate circuit 11. A square wave (K) that has passed gate circuit 11 is counted and the third square wave K is acknowledged as the ultrasonic wave arrival timing and an attainment impulse wave J is outputted. In this manner, since the zero crossing time Z of wave Wm with the maximum amplitude is adopted as the ultrasonic wave arrival timing, the change of the zero crossing time Z due to interference such as reflected waves of the previous measurement and environmental noise is small, and the received wave W arrival timing for measuring a propagation time difference is specified with good precision.

Subtracting three rectangular waves from this "ultrasonic wave arrival timing" is used to accurately calculate (according to Eshita) the time of flight, or wave propagation time, not to determine the correctness of the reception time, and still by use of a chronological position Ts as the characteristic value of the signal or its envelope, as claimed.

As Wm is clearly defined in paragraphs [0026] and [0032] as the wave (Wm) with the maximum amplitude that is adopted as the "ultrasonic wave arrival timing." The time of the maximum energy wave Wm is used by Eshita as arrival time t_0. Wm cannot be a characteristic value that is equivalent to applicant's claimed characteristic value as the characteristic value as claimed is the chronologic position Ts of a focal point of either the ultrasonic wave or its envelope.

For that matter, if the time of the maximum energy wave Wm is equivalent to Eshita's reception time t_0, as claimed, Eshita's receiver unit cannot be said also use a time (t_1) of the characteristic value (asserted by the Examiner to be Wm). That is, if the time of WM is the reception time t_0, how can it also be the time (t1) of the characteristic value?

At paragraph [0032], Eshita asserts that the time from transmission to this time of reception (i.e., the ultrasonic wave arrival timing) is used for propagation time difference determination, i.e., time of flight calculating, is specified with sufficient accuracy.

By determining the correct reception time t_0, appellant's invention as claimed more accurately calculates propagation time, and other time-of-flight related calculations, as distinguished from prior art devices such as Eshita.

Eshita does not teach or suggest use determining a time (t_1) of a characteristic value, said characteristic value comprising the determined chronological position Ts of a focal point of either the ultrasound signal or its envelope curve (6), as claimed (emphasis added)., nor using a time shift (Δt) of the time (t_1) of a characteristic value relative to the reception time (t_0) to determine a correct time value for the reception time (t_0), as asserted by the Examiner at page 20, first full paragraph.

While Ai may teach a centroid approach to estimate modulation peak in broad bandwidth interferometer with means for determining a chronological position of a focal point of a signal T_s, Ai does not overcome the shortcomings of Eshita.

Ai does not teach or suggest using a time shift (Δt) of the time (t_1) of the characteristic value relative to the reception time (t_0) to determine a correct time value for the reception time (t_0), where the chronological position Ts of a focal point of an ultrasonic signal or it envelope curve is the characteristic value (emphasis added), as claimed.

While appellant argues in the APPEAL BRIEF that one skilled in the art would not have undertaken to modify Eshita by the teachings of Ai, for the reasons stated therein, appellant respectfully asserts that even if the teaching of Ai are incorporated to modify Eshita, the proposed combination still would not realize the invention as claimed, and claims 1, 4, 6 and 7 are not obvious under §103(a) over Eshita in view of Ai, therefore

3. Appellants Reply to the Examiner's "(10) Response to Argument" with respect to the rejection claims 1 and 4-7 under §103(a) over applicants admitted prior art (AAPA) in view of Eshita further in view of Ai.

At page 30 of the Answer, the Examiner asserts that appellant's arguments in his APPEAL BRIEF have been fully addressed (above) with respect to the rejection of claims 1, 4, 6 and 7, as best due to the indefiniteness, under §103(a) as unpatentable over Eshita in view of Ai.

In response, appellant respectfully asserts that it would not have been obvious to modify the invention of AAPA as proposed to be modified by Eshita, to explicitly indicate that the receiver unit determines a time (t_1) of a characteristic

value, said characteristic value comprising the determined chronological position Ts of a focal point of either the ultrasound signal or its envelope curve (6), and using a time shift (Δt) of the time (t_1) of the characteristic value relative to the reception time (t_0) to determine a correct time value for the reception time (t_0), as claimed.

In view of the foregoing discussion, it is respectfully requested that the Honorable Board of Patent Appeals and Interferences overrule the final rejection of claims 1 and 4-7 under the second paragraph of section 112 and over the cited art, and hold that appellant's claims be allowable.

Respectfully Submitted,

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XII. FURTHER EVIDENCE APPENDIX.

Attachment A.

The first and 37th slides from a power point slide presentation on **35 U.S.C. 112 2nd** paragraph, prepared by Julie Burke, Training Quality Assurance Specialist at the United Sates Patent and Trademark Office (TC 1600 QAS).

Attachment B.

An 8-page translation of Eshita, provided to appellant on June 25, 2007 (which date may be verified by viewing pages 303-310 of the PAIR file history, as of October 3, 2010).

Attachment C.

A full 24 page translation of Eshita, including drawing figures, provided to appellant on October 4, 2010.

PTO 09-2864

CC=JP
DATE=20030221
KIND=Kokai
PN=2003050145

METHOD AND APPARATUS FOR MEASURING ULTRASONIC FLOW VELOCITY
[Choonpa Ryusoku Sokutei Hoho Oyobi Sochi]

Kazuo Eshimo et al.

UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. FEBRUARY 2009
TRANSLATED BY Schreiber Translations, Inc.

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INVENTOR(S)	(72):	Kazuo Eshimo et al.
APPLICANT(S)	(71):	Kansai Gas Meter K.K., etc.
DESIGNATED CONTRACTING STATES	(81):	
TITLE	(54):	METHOD AND APPARATUS FOR MEASURING ULTRASONIC FLOW VELOCITY
FOREIGN TITLE	[54A]:	Choonpa Ryusoku Sokutei Hoho Oyobi Sochi

/2[1]

Claims

1. A method for measuring an ultrasonic flow velocity, characterized by the fact that in a method for measuring an ultrasonic flow velocity that arranges ultrasonic vibrators respectively at the upstream and the downstream of a measuring fluid flowing in an ultrasonic flow velocity measuring tube, generates and transmits ultrasonic waves from the above-mentioned ultrasonic vibrators to each other, receives the transmitted ultrasonic waves from each other, and measures the flow velocity based on the difference in the propagation time of the ultrasonic waves attained from the comparison of each received wave, the reception is decided by specifying the time when the wave of the first part of the above-mentioned received waves arrives at a reference value; a prescribed wave number is counted from the reference value arrival time of the received waves; and the zero crossing time of the wave with the maximum amplitude or waves at its vicinity after counting the prescribed wave number is

[1] Numbers in the margin indicate pagination in the foreign text.

adopted as an ultrasonic wave arrival timing for measuring a propagation time difference.

2. An apparatus for measuring an ultrasonic flow velocity, characterized by the fact that an apparatus for measuring an ultrasonic flow velocity that arranges ultrasonic vibrators respectively at the upstream and the downstream of a measuring fluid flowing in an ultrasonic flow velocity measuring tube, generates and transmits ultrasonic waves from the above-mentioned ultrasonic vibrators to each other, receives the transmitted ultrasonic waves from each other, and measures the flow velocity based on the difference in the propagation time of the ultrasonic waves attained from the comparison of each received wave, is equipped with a reception decision means that decides the reception by specifying the time when the wave of the first part of the above-mentioned received waves arrives at a reference value; a count means that counts a prescribed wave number from the reference value arrival time of the received waves; and a timing specification means that adopts the zero crossing time of the wave with the maximum amplitude or waves at its vicinity after counting the prescribed wave number as an ultrasonic wave arrival timing for measuring a propagation time difference.

Detailed explanation of the invention

[0001]

(Technical field of the invention)

The present invention pertains to a method and apparatus for measuring an ultrasonic flow velocity that measures the flow velocity of gases and other fluids by utilizing ultrasonic waves.

[0002]

(Prior art)

In conventional methods for attaining the amount of flow of gases and other fluids, first, the flow velocity of fluids is continuously and periodically measured, and the amount of flow is calculated based on the flow velocity. As one of these methods for measuring the flow velocity of fluids, a method utilizing ultrasonic waves has been known.

[0003] The principle of such a method for measuring an ultrasonic flow velocity is explained as follows by Figure 3. In Figure 3, (1) is an ultrasonic flow velocity measuring tube in which fluids such as gases flow. In the ultrasonic flow velocity measuring tube (1), ultrasonic vibrators (2) and (3) are respectively arranged with a prescribed distance at the upstream and the downstream of a flow direction. These ultrasonic vibrators (2) and (3) are driven and vibrated by driving pulses from a driving pulse

generating circuit (4), generate and transmit ultrasonic waves, and receives transmitted ultrasonic waves. When the ultrasonic vibrators (3) and (2) vibrate, the received waves are output from a received wave amplifying circuit (5).

[0004] Since the difference between the propagation time until the ultrasonic waves transmitted forward to the flow from the upstream side ultrasonic vibrator (2) are received by the downstream side ultrasonic vibrator (3) and the propagation time until the ultrasonic waves transmitted backward to the flow from the downstream side ultrasonic vibrator (3) are received by the upstream side ultrasonic vibrator (2) has a relationship with the flow velocity, the flow velocity of the fluid is measured by attaining the propagation time difference of these ultrasonic waves through the utilization of clock waves, etc.

[0005] In addition, in Figure 3, (6) is a switching circuit for switching the connection of each ultrasonic vibrator (2) and (3), driving pulse generating circuit (4), and received wave amplifying circuit (5). First, the driving pulse generating circuit (4) and the upstream side ultrasonic vibrator (2) are connected, and the downstream side ultrasonic vibrator (3) and the received wave amplifying circuit (5) are connected. After measuring the

propagation time from the upstream side to the downstream side, the connections are switched by the operation of said switching circuit (6) so that the driving pulse generating circuit (4) and the downstream side ultrasonic vibrator (3) are connected and the upstream side ultrasonic vibrator (2) and the received wave amplifying circuit (5) are connected, and the propagation time from the downstream side to the upstream side is measured.

[0006] On the other hand, in order to measure the propagation time of the ultrasonic waves, it is necessary to specify the ultrasonic wave arrival timing in the received wave (W) being output from the received wave amplifying circuit (5). In the prior art, as shown in Figure 4, the reception has been decided by specifying the time when the wave (especially, initial wave) of the first part of the received wave (W) arrives at a reference voltage value Vth for the first time, and the zero crossing time (Z′) right after the time when the received wave (W) arrives at the reference voltage value Vth has been adopted as the ultrasonic wave arrival timing.

[0007]

(Problems to be solved by the invention)

However, the received wave (W) that is output from the received wave amplifying circuit (5) undergoes interference

such as reflected waves of the ultrasonic waves of the previous measurement and environmental noises, and its zero crossing time is sometimes changed. The change of the zero crossing time of the received wave (W) is small in the waves in the part with a large amplitude such as wave with the maximum amplitude and waves at its vicinity, however the change is large in the wave of the part with a small amplitude such as wave of the first half part (especially, initial wave). For this reason, like the prior art, if the zero crossing time (Z') of the wave of the first half part of the received wave (W) was adopted as the ultrasonic wave arrival timing, the ultrasonic wave arrival timing could not be specified with good precision.

[0008] Needless to say, the decision is decided by specifying the time when the wave with the maximum amplitude or waves at its vicinity among the received wave (W) arrives at the reference voltage value, and the zero crossing time right after the time when the received wave (W) arrives at the reference voltage value is adopted as the ultrasonic wave arrival timing. However, in the wave with the maximum amplitude or waves at its vicinity, the amplitude difference of the adjacent waves was considerably small, and the reception decision based on the same wave was difficult.

[0009] The present invention considers the above-mentioned problems, and its purpose is to provide a method and

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apparatus for measuring an ultrasonic flow velocity that can specify the ultrasonic wave arrival timing for measuring a propagation time difference with good precision and can secure sufficient measurement precision.

[0010]

(Means to solve the problems)

In order to achieve the above-mentioned purpose, the method for measuring an ultrasonic flow velocity of the present invention is characterized by the fact that in the method for measuring an ultrasonic flow velocity that arranges ultrasonic vibrators respectively at the upstream and the downstream of a measuring fluid flowing in an ultrasonic flow velocity measuring tube, generates and transmits ultrasonic waves from the above-mentioned ultrasonic vibrators to each other, receives the transmitted ultrasonic waves from each other, and measures the flow velocity based on the difference in the propagation time of the ultrasonic waves attained from the comparison of each received wave, the reception is decided by specifying the time when the wave of the first part of the above-mentioned received waves arrives at a reference

value; a prescribed wave number is counted from the reference value arrival time of the received waves; and the zero crossing time of the wave with the maximum amplitude or waves at its vicinity after counting the prescribed wave number is adopted as an ultrasonic wave arrival timing for measuring a propagation time difference.

[0011] According to this method, since the reception is decided by the wave of the first part having a large amplitude difference of the adjacent waves in the received waves, the reception can always be decided based on the same wave. In addition, since the zero crossing time of the wave with the maximum amplitude or waves at its vicinity after counting a prescribed wave number from the reference value arrival time of the received waves is adopted as the ultrasonic wave arrival timing, the change of the zero crossing time due to interference such as reflected waves of the previous measurement and environmental noises is small, and the ultrasonic wave arrival timing for measuring a propagation time difference can be specified with good precision. Here, the wave of the first part of the received wave means a wave in front of waves in the vicinity of the wave with the maximum amplitude of the received waves.

[0012] Moreover, the apparatus for measuring an ultrasonic flow velocity of the present invention is characterized by the fact that the apparatus for measuring an ultrasonic flow velocity that arranges ultrasonic vibrators respectively at the upstream and the downstream of a measuring fluid flowing in an ultrasonic flow velocity measuring tube, generates and transmits ultrasonic waves from the above-mentioned ultrasonic vibrators to each other, receives the transmitted ultrasonic waves from each other, and measures the flow velocity based on the difference in the propagation time of the ultrasonic waves attained from the comparison of each received wave, is equipped with a reception decision means that decides the reception by specifying the time when the wave of the first part of the above-mentioned received waves arrives at a reference value; a count mean that counts a prescribed wave number from the reference value arrival time of the received waves; and a timing specification means that adopts the zero crossing time of the wave with the maximum amplitude or waves at its vicinity after counting the prescribed wave number as an ultrasonic wave arrival timing for measuring a propagation time difference. According to this apparatus, the method for measuring an ultrasonic flow velocity of Claim 1 can be simply and reliably realized.

[0013]

(Embodiment of the invention)

Figure 1 shows the apparatus for measuring an ultrasonic flow velocity for applying the present invention.

[0014] In Figure 1, (1) is the ultrasonic flow velocity measuring tube, (2) and (3) are ultrasonic vibrators arranged with a prescribed distance at the upstream and the downstream in a flowing direction, and (4) is a driving pulse generating circuit for generating driving pulses. (5) is a received wave amplifying circuit for outputting received waves when ultrasonic waves are received by the ultrasonic vibrators (2) and (3). (6) is a switching circuit for switching the connection of each ultrasonic vibrator (2) and (3), driving pulse generating circuit (4), and received wave amplifying circuit (5), and these parts are the same as those shown in Figure 3.

[0015] In this embodiment, a first comparison circuit (7) is installed at the output side of the received wave amplifying circuit (5). The first comparison circuit (7), as shown in Figures 2(a) and (b), compares the received wave (W) being output from the received wave amplifying circuit (5) with 0 V and outputs a rectangular wave (K) with the same period as that of the received wave (W) each

time the received wave (W) exceeds 0 V. Since the rectangular wave (K) has the same period as that of the received wave (W), it is continuously output while corresponding to the received wave (W) and used in counting the wave number of the received wave (W) in a n-base counter (12) that will be mentioned later.

[0016] In addition, a second comparison circuit (8) and a latch circuit (9) are installed at the output side of the received wave amplifying circuit (5). The second comparison circuit (8), as shown in Figure 2(a), compares the received wave (W) being output from the received wave amplifying circuit (5) with the reference voltage value Vth being output from the reference voltage generating circuit (10) and outputs a reception decision signal when the received wave (W) arrives at the reference voltage value Vth for the first time, so that the reception decision of the ultrasonic waves is made. In this embodiment, the reference voltage value Vth is set so that the second wave (W2) of the received wave (W) arrives at the reference voltage value Vth during its rise.

[0017] Moreover, the latch circuit (9) adopts a closed state unless the reception decision signal is transmitted from the second comparison circuit (8), and as shown in Figure 2(c), when the reception decision signal transmitted

from the second comparison circuit (8), a gate pulse (G) is output.

[0018] A gate circuit (11) is installed at the output side of the first comparison circuit (7) and the latch circuit (9). The gate circuit (11), as shown in Figure 2(d), passes the rectangular wave (K) being output from the first comparison circuit (7), when the gate pulse (G) is output from the latch circuit (9), and extracts only the rectangular wave (K) after the time when the received wave (W) arrives at the reference voltage value Vth.

[0019] A n-base counter (12) is installed at the output side of the gate circuit (11). The n-base counter (12), as shown in Figure 12(e), counts the rectangular wave (K) passed through the gate circuit (11). When a prescribed wave number (2 waves in this embodiment) of these rectangular waves (K) is counted, that is, when the third rectangular wave (K) rises after starting counting of the rectangular wave (K), it is adopted as the ultrasonic wave arrival timing, and an ultrasonic wave arrival pulse (J) is output. The prescribed wave number (2 waves) of the rectangular wave (K) corresponds to the wave number from the second wave (W2) of the received wave (W) to the wave (Wm) with the maximum amplitude, and the time when the

third wave of the rectangular wave (K) rises agrees with the zero crossing time (Z) of the wave (Wm) with the /4

maximum amplitude wave of the received wave (W).

[0020] Next, the method for measuring an ultrasonic flow velocity by using the apparatus shown in Figure 1 will be explained.

[0021] First, a driving pulse is generated in the diving pulse generating circuit (4) and applied to the upstream side ultrasonic vibrator (2) to transmit ultrasonic waves from the ultrasonic vibrator (2). The transmitted ultrasonic waves are received by the downstream side ultrasonic vibrator (3), and the received wave (W) is output from the received wave amplifying circuit. The received wave (W), as shown in Figure 2(a), is a vibration waveform in which the amplitude is raised from the first wave (W1) to the second wave (W2) and the third wave (W3) and eventually attenuated, and the amplitude difference of the adjacent waves is large in the wave of the first part (especially, initial wave), and the amplitude difference of the adjacent waves is small in the wave (Wm) with the maximum amplitude and waves at its vicinity.

[0022] The first comparison circuit (7), as shown in Figure 2(a), compares the receives wave (W) being output from the

received wave amplifying circuit (5) with 0 V and outputs the rectangular wave (K) with the same period as that of the received wave (W) each time the received wave (W) exceeds 0 V.

[0023] On the other hand, the second comparison circuit (8), as shown in Figure 2(a), compares the received wave (W) being output from the received wave amplifying circuit (5) with the reference voltage value Vth being output from the reference voltage generating circuit (10) and transmits a reception decision signal when the received wave (W) arrives at the reference voltage value Vth, so that the reception decision of the ultrasonic waves is made. In this manner, since the reception is decided by the wave (the second wave in this embodiment) of the first part with a large amplitude difference of the adjacent waves, the reception can always be decided based on the same wave (second wave).

[0024] The latch circuit (9), as shown in Figure 2(c), outputs the gate pulse (G) when the reception decision signal is transmitted from the second comparison circuit (8).

[0025] The gate circuit (11), as shown in Figure 2(d), passes the rectangular wave (K) being output from the first comparison circuit (7), when the gate pulse (G) is output

from the latch circuit (9), and extracts only the rectangular wave (K) after the time when the received wave (W) arrives at the reference voltage value Vth.

[0026] The n-base counter (12), as shown in Figure 12(e), counts the rectangular waves (K) passed through the gate circuit (11). When a prescribed wave number (2 waves in this embodiment) of these rectangular waves (K) is counted, that is, when the third rectangular wave (K) rises after starting counting of the rectangular wave (K), it is adopted as the ultrasonic wave arrival timing, and the ultrasonic wave arrival pulse (J) is output. In this manner, since the zero crossing time (Z) of the wave (Wm) with the maximum amplitude is adopted as the ultrasonic wave arrival timing, the change of the zero crossing time (Z) due to interference such as reflected waves of the previous measurement and environmental noises is small, and the received wave (W) arrival timing for measuring a propagation time difference can be specified with good precision.

[0027] Next, the time from the transmission time of the ultrasonic waves to the received wave arrival timing is attained as a propagation time τ of the forward ultrasonic waves.

[0028] After attaining the propagation time τ of the forward ultrasonic waves, the connections are switched by the operation of the switching circuit (6) so that the driving pulse generating circuit (4) and the downstream side ultrasonic vibrator (3) are connected and the upstream side ultrasonic vibrator (2) and the received wave amplifying circuit (5) are connected, and a backward ultrasonic wave propagation time τ' is attained similarly to the above-mentioned propagation time. Since these forward and backward ultrasonic wave propagation times τ and τ' generate a propagation time difference $(\tau - \tau')$ that is changed in accordance with the flow velocity, the flow velocity of a fluid is attained based on the propagation time difference $(\tau - \tau')$. If necessary, the amount of flow of the fluid is further attained.

[0029] In addition, in this embodiment, the second wave (W2) of the received wave (W) has been used in the reception decision; however, other waves of the first part of the received wave (W) may also be used.

[0030] Moreover, the zero crossing time (Z) of the wave (Wm) with the maximum amplitude of the received wave (W) has been adopted as the ultrasonic wave arrival timing, however the zero crossing time of waves in the vicinity of

the wave (Wm) with the maximum amplitude may also be adopted as the ultrasonic wave arrival timing.

[0031] Furthermore, the prescribed wave number being counted in the n-base counter (12) has been two waves, however the prescribed wave number may also be changed in accordance with the characteristic of the received wave (W) itself and the wave of the first half part of the received part (W) being used in the reception decision. For example, if the wave number from the wave being used in the reception decision in the received wave (W) to the wave with the maximum amplitude or waves at its vicinity is n waves, the prescribed wave number being counted may be n waves.

[0032] In addition, the propagation time of the ultrasonic waves has been the time until the ultrasonic wave arrival time from the time when the ultrasonic waves are transmitted; however, the propagation time may also be the time from the transmission time of the ultrasonic waves to the time when a prescribed time is subtracted from or added to the ultrasonic wave arrival timing. For example, the time when the ultrasonic waves are received for the first time by subtracting a prescribed time from the received wave (W) arrival timing, and the time from the transmission time of the ultrasonic waves to the reception time of the

ultrasonic waves for the first time may also be adopted as the propagation time of the ultrasonic waves.

[0033] Moreover, without being limited to the above-mentioned circuit constitution, if the reception is decided by specifying the time when the wave of the first part of the received wave (W) arrives at the reference value, a prescribed wave number is counted from the reference value arrival time of the received wave (W), and the wave (Wm) with the maximum amplitude or waves at its vicinity after counting the prescribed wave number is adopted as the ultrasonic wave arrival timing for measuring a propagation time difference, other circuit constitutions may also be adopted.

[0034]

(Effects of the invention)

According to the invention of Claim 1, since the reception is decided by the wave of the first part having a large amplitude difference of the adjacent waves in the received waves, the reception can always be decided based on the same wave. In addition, since the zero crossing time of the wave with the maximum amplitude or waves at its vicinity after counting a prescribed wave number from the reference value arrival time of the

/5

received waves is adopted as the ultrasonic wave arrival timing, the change of the zero crossing time due to interference such as reflected waves of the previous measurement and environmental noises is small, and the ultrasonic wave arrival timing for measuring a propagation time difference can be specified with good precision. Moreover, sufficient measurement precision can be secured.

[0035] According to the invention of Claim 2, the method for measuring an ultrasonic flow velocity of Claim 1 can be simply and reliably realized.

Brief description of the figures

Figure 1 is a block diagram showing an example of the apparatus for measuring an ultrasonic flow velocity for applying the present invention.

Figure 2 is an output waveform diagram showing received wave, rectangular wave, gate pulse, and received wave arrival pulse.

Figure 3 is a block diagram showing a conventional apparatus for measuring an ultrasonic flow velocity.

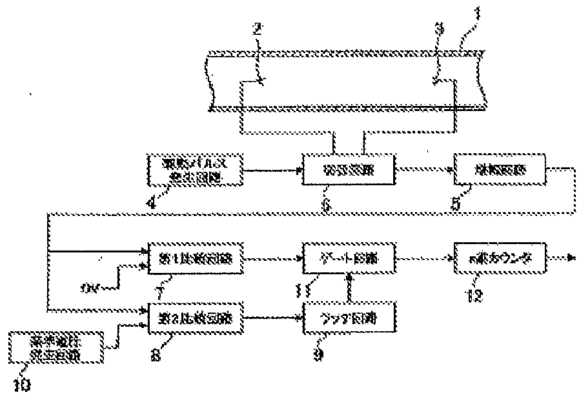
Figure 4 is an output waveform diagram showing a received wave in the apparatus for measuring an ultrasonic flow velocity of Figure 3.

Explanation of numerals:

1 Ultrasonic flow velocity measuring tube

2, 3 Ultrasonic vibrators

// Insert Figures 1-4 //



4 Driving pulse generating circuit

5 Amplifying circuit

6 Switching circuit

7 First comparison circuit

8 Second comparison circuit

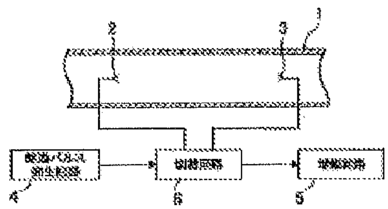
9 Latch circuit

10 Reference voltage generating circuit

11 Gate circuit

12 n-base counter

【図3】

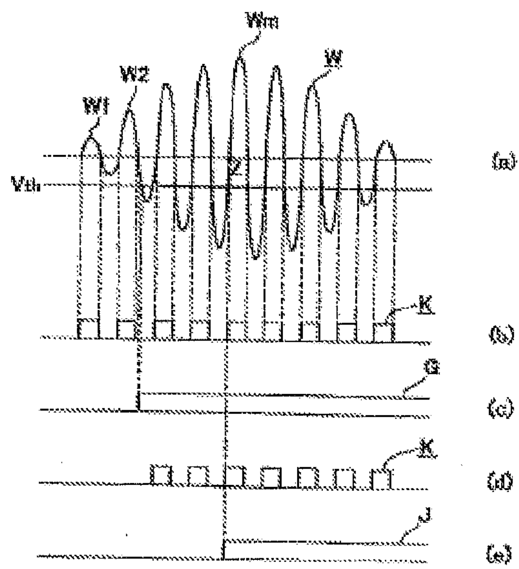


4 Driving pulse generating circuit

5 Amplifying circuit

6 Switching circuit

【図2】



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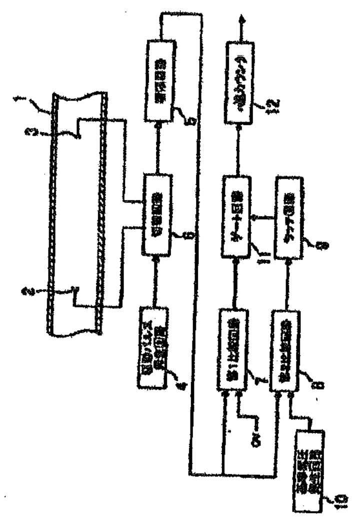
(54) METHOD AND APPARATUS FOR ULTRASONIC FLOW-VELOCITY MEASUREMENT

(57) Abstract:

PROBLEM TO BE SOLVED: To provide a method and an apparatus for an ultrasonic flow-velocity measurement where the arrival timing of ultrasonic waves for measuring a propagation time difference can be specified with full accuracy, and a full measurement accuracy can be ensured.

SOLUTION: The ultrasonic waves are generated and transmitted from an ultrasonic transducer 2 and an ultrasonic transducer 3 arranged on the upstream side and the downstream side of a measuring fluid, flowing in an ultrasonic flow-velocity measuring tube 1, the transmitted ultrasonic waves are received mutually, and a flow velocity is measured, on the basis of the difference in the propagation times between the ultrasonic waves found by comparing respective received waves W. By specifying the time at which second waves in the first half part of the received waves W reach a reference voltage value Vth, their reception is determined, the prescribed number of waves is counted from the time at which the received waves W reach the reference voltage value, and the zero-crossing point of time of maximum-amplitude waves Wm, after counting the prescribed number of waves, is regarded as the arrival timing of the ultrasonic waves for measuring the propagation time difference.



[JP,2003-050145,A]

CLAIMS

[Claim(s)]
[Claim 1] While arranging an ultrasonic transducer, respectively to the upstream [of the Measurement Division fluid which flows through the ultrasonic flow-velocity measuring pipe], and lower stream side and carrying out birth transmission of the supersonic wave mutually from said each ultrasonic transducer In the ultrasonic flow-velocity measuring method which measures the flow velocity based on the difference of the propagation time of the supersonic wave which received the transmitted supersonic wave mutually and was searched for from the comparison of each received wave By specifying the event of the wave for the first portion of said received wave reaching a reference value, perform a receipt-of-letter judging and a predetermined wave number is counted from the reference-value attainment event of the received wave. The ultrasonic flow-velocity measuring method characterized by making the zero cross event of the peak swing wave after the predetermined wave-number count, or the wave of the neighborhood into the ultrasonic reaching timing for propagation time difference determination.
[Claim 2] While an ultrasonic transducer is arranged at the upstream [of the Measurement Division fluid which flows through the ultrasonic flow-velocity measuring pipe], and lower stream side, respectively and carrying out birth transmission of the supersonic wave mutually from said each ultrasonic transducer In the ultrasonic flow-velocity measuring device which measures the flow velocity based on the difference of the propagation time of the supersonic wave which received the transmitted supersonic wave mutually and was searched for from the comparison of each received wave A receipt-of-letter judging means to perform a receipt-of-letter judging by specifying the event of the wave for the first portion of said received wave reaching a reference value, A count means to count a predetermined wave number from the reference-value attainment event of the received wave, The ultrasonic flow-velocity measuring device which is equipped with the timing specification means which makes the zero cross event of the peak swing wave after the predetermined wave-number count, or the wave of the neighborhood the ultrasonic reaching timing for propagation time difference determination, and is characterized by things.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the ultrasonic flow-velocity measuring method and apparatus which measure the flow velocity of gas and other fluid using a supersonic wave.
[0002]
[Description of the Prior Art] Conventionally, it faces in quest of gas and other fluid flow, and the continuous thing for which it is, and it carries out, and measures periodically, and a discharge is calculated based on this is first performed in the flow velocity of the fluid. And the approach using a supersonic wave is known as one of the

flow-velocity measuring methods of such fluid.
[0003] It is as follows when drawing 3 explains the principle of this ultrasonic flow-velocity measuring method. In drawing 3 , (1) is the ultrasonic flow-velocity measuring pipe with which fluid, such as gas, flows through a core. In this ultrasonic flow-velocity measuring pipe (1), predetermined distance is separated and an ultrasonic transducer (2) and (3) are arranged at the upstream [of the direction of flow], and lower stream side. While this ultrasonic transducer (2) and (3) are driven by the driving pulse from a drive pulse generation circuit (4), they vibrate and birth transmission of the supersonic wave is carried out, it is what receives the transmitted supersonic wave. It is outputted from a receiving amplifier (5) in the received wave when the ultrasonic transducer (3) and (2) vibrate.
[0004] And propagation time until the supersonic wave transmitted to the direction of easy flow from the ultrasonic transducer by the side of the upstream (2) to flow is received with the ultrasonic transducer by the side of the lower stream (3), [the difference with propagation time until the supersonic wave transmitted to the reverse direction from the ultrasonic transducer by the side of the lower stream (3) to flow is received by the ultrasonic transducer by the side of the upstream (2)] Since [/ flow velocity], the flow velocity of the fluid is measured by carrying out using a clock wave etc. and searching for the propagation time difference of this supersonic wave.
[0005] In addition, it is the switching circuit where (6) changes bonding of each ultrasonic transducer (2), (3), a drive pulse generation circuit (4), and a receiving amplifier (5) in drawing 3 . A drive pulse generation circuit (4), and the ultrasonic transducer by the side of the upstream (2), the ultrasonic transducer by the side of the lower stream (3) and a receiving amplifier (5) are connected first. After measuring the propagation time from the upstream side to the lower stream side, by actuation of this switching circuit (6) The ultrasonic transducer (3) by the side of a drive pulse generation circuit (4) and the lower stream, It changes so that a receiving amplifier (5) may be connected with the ultrasonic transducer by the side of the upstream (2), and the propagation time from the lower stream side to the upstream side is measured.
[0006] By the way, in order to measure the propagation time of a supersonic wave, it is necessary to specify ultrasonic reaching timing in the received wave (W) outputted from a receiving amplifier (5). And a receipt-of-letter judging is performed by specifying the event of the wave (especially initial wave) for the first portion of a received wave (W) reaching the reference-voltage value Vth for the first time, as conventionally shown in drawing 4 . The next zero cross event (Z') was made into ultrasonic reaching timing the event of the received wave (W) reaching the reference-voltage value Vth.
[0007]
[Problem to be solved by the invention] However, the received wave (W) outputted from a received wave amplifier (5) may receive interference of the reflected wave of the supersonic wave at the time of determination, ambient noise, etc. last time, and the zero cross event may be changed. [floating at the zero cross event of this received wave (W)] Although the amplitude is small by the wave of a large part like a peak swing wave or the wave of the neighborhood, like the wave for the first portion (especially initial wave) Since the amplitude is large by the wave of a small part, In some which make the zero cross event (Z') of the wave for the first portion of a received wave (W) ultrasonic reaching timing like before, there was a problem that ultrasonic reaching timing could not

be specified with sufficient accuracy.
[0008] By specifying the event of the peak swing wave of a received wave (W) or the wave of the neighborhood reaching a reference-voltage value for the first time from the first, a receipt-of-letter judging is performed and making the next zero cross event into ultrasonic reaching timing the event of the received wave (W) reaching a reference-voltage value can think. However, there was a problem that a peak swing wave or the wave of the neighborhood had the quite small amplitude difference of adjacent waves, and it was difficult to perform a receipt-of-letter judging on the basis of the same wave.
[0009] This invention aims at offer of the ultrasonic flow-velocity measuring method which it is made in view of an above-mentioned problem, and the ultrasonic reaching timing for propagation time difference determination can be specified with sufficient accuracy, as a result can secure sufficient accuracy of measurement, and an apparatus.
[0010]
[Means for solving problem] [the ultrasonic flow-velocity measuring method concerning this invention] in order to attain the above-mentioned object While arranging an ultrasonic transducer, respectively to the upstream [of the Measurement Division fluid which flows through the ultrasonic flow-velocity measuring pipe], and lower stream side and carrying out birth transmission of the supersonic wave mutually from said each ultrasonic transducer In the ultrasonic flow-velocity measuring method which measures the flow velocity based on the difference of the propagation time of the supersonic wave which received the transmitted supersonic wave mutually and was searched for from the comparison of each received wave By specifying the event of the wave for the first portion of said received wave reaching a reference value, perform a receipt-of-letter judging and a predetermined wave number is counted from the reference-value attainment event of the received wave. It is characterized by making the zero cross event of the peak swing wave after the predetermined wave-number count, or the wave of the neighborhood into the ultrasonic reaching timing for propagation time difference determination.
[0011] Since the amplitude difference of the adjacent waves in a received wave performs a receipt-of-letter judging by the wave for the large first portion according to this, a receipt-of-letter judging can always be performed on the basis of the same wave. And further since the zero cross event of the peak swing wave after a predetermined wave-number count or the wave of the neighborhood is made into ultrasonic reaching timing from the reference-value attainment event of a received wave There is almost no floating at the zero cross event by interference of the reflected wave of the last determination, ambient noise, etc., and the ultrasonic reaching timing for propagation time difference determination can be specified with sufficient accuracy. In addition, the wave for the first portion of this received wave means the wave before the wave near the peak swing wave of a received wave.
[0012] [moreover, the ultrasonic flow-velocity measuring device concerning this invention] While an ultrasonic transducer is arranged at the upstream [of the Measurement Division fluid which flows through the ultrasonic flow-velocity measuring pipe], and lower stream side, respectively and carrying out birth transmission of the supersonic wave mutually from said each ultrasonic transducer In the ultrasonic flow-velocity measuring device which measures the flow velocity based on the difference of the propagation time of the supersonic wave which received the transmitted supersonic

wave mutually and was searched for from the comparison of each received wave A receipt-of-letter judging means to perform a receipt-of-letter judging by specifying the event of the wave for the first portion of said received wave reaching a reference value, A count means to count a predetermined wave number from the reference-value attainment event of the received wave, [according to this which is equipped with the timing specification means which makes the zero cross event of the peak swing wave after the predetermined wave-number count, or the wave of the neighborhood the ultrasonic reaching timing for propagation time difference determination, and is characterized by things] The ultrasonic flow-velocity measuring method according to claim 1 is certainly [simply and] realizable.

[0013]

[Mode for carrying out the invention] Drawing 1 shows the ultrasonic flow-velocity measuring device for carrying out this invention.

[0014] The ultrasonic transducer with which it has been arranged by (1) separating predetermined distance to the upstream [of the direction of flow], and lower stream side in drawing 1 , as for the ultrasonic flow-velocity measuring pipe, (2), and (3), The receiving amplifier where (4) outputs a received wave when the drive pulse generation circuit which generates a driving pulse, and (5) receive a supersonic wave by an ultrasonic transducer (2) and (3), (6) is a switching circuit which changes bonding of each ultrasonic transducer (2), (3), a drive pulse generation circuit (4), and a receiving amplifier (5), and these of it are the same as that of what was shown in drawing 3 .

[0015] In this embodiment, the 1st comparison circuit (7) is established in the output side of the receiving amplifier (5). This 1st comparison circuit (7) outputs a received wave (W) and the square wave (K) of this period, whenever it compares with 0V the received wave (W) outputted from a receiving amplifier (5) and a received wave (W) exceeds 0V, as shown in drawing 2 (a) and (b). This square wave (K) is used when it corresponds to a received wave (W), it is continuously outputted if it is **, and counting the wave number of a received wave (W) in the below-mentioned n ** counter (12), since it is a received wave (W) and this period.

[0016] Moreover, similarly the 2nd comparison circuit (8) and latch circuitry (9) are established in the output side of the receiving amplifier (5). The received wave (W) outputted from a receiving amplifier (5) as this 2nd comparison circuit (8) is shown in drawing 2 (a), When the reference-voltage value Vth outputted from circuit generating reference voltage (10) is compared and a received wave (W) reaches the reference-voltage value Vth for the first time, a receiving decision signal is outputted, and thereby, the receipt-of-letter judging of a supersonic wave is performed. In this embodiment, as the 2nd wave (W2) of a received wave (W) falls, the reference-voltage value Vth is set up to reach the reference-voltage value Vth.

[0017] Moreover, latch circuitry (9) outputs a gate pulse (G), when the receiving decision signal has been transmitted from the 2nd comparison circuit (8) as a closed state is taken and it is shown in drawing 2 (c) unless a receiving decision signal is transmitted from the 2nd comparison circuit (8).

[0018] The gate circuit (11) is prepared in the output side of the 1st comparison circuit (7) and latch circuitry (9). As shown in drawing 2 (d), when a gate pulse (G) is outputted from latch circuitry (9), this gate circuit (11) passes the square wave (K) outputted from the 1st comparison circuit (7), and extracts a next square wave (K) the event of a received

wave (W) reaching the reference-voltage value Vth.

[0019] n ** counter (12) is formed in the output side of the gate circuit (11). When this n ** counter (12) counts the square wave (K) which has passed the gate circuit (11) as shown in drawing 2 (e) and the predetermined wave-number (this embodiment two waves) count of these square waves (K) is carried out, That is, after starting the count of a square wave (K), the time of the square wave (K) of eye three waves rising is made into ultrasonic reaching timing, and an ultrasonic attainment impulse wave (J) is outputted. The predetermined wave number (two waves) of this square wave (K) is equivalent to the wave number from the 2nd wave (W2) of a received wave (W) to a peak swing wave (Wm), and when the 3rd wave of a square wave (K) attends, it is in agreement with (Z) at the zero cross event of the peak swing wave (Wm) of a received wave (W).

[0020] Next, the ultrasonic flow-velocity measuring method using the apparatus shown in drawing 1 is explained.

[0021] First, a driving pulse is generated in a drive pulse generation circuit (4). By impressing it to the ultrasonic transducer by the side of the upstream (2), a supersonic wave is transmitted from an ultrasonic transducer (2), the ultrasonic transducer by the side of the lower stream (3) receives the transmitted supersonic wave, and a received wave (W) is outputted from a receiving amplifier. This received wave (W) is the oscillatory wave form which the amplitude decreases soon, after the 2nd wave (W2), the 3rd wave (W3), and the amplitude become large rather than the 1st wave (W1), as shown in drawing 2 (a). The amplitude difference of the waves which adjoin each other by the wave for the first portion (especially early wave) is large, and the amplitude difference of adjacent waves is small by the peak swing wave (Wm) and the wave of the neighborhood.

[0022] In the 1st comparison circuit (7), as shown in drawing 2 (a) and (b), whenever it compares with 0V the received wave (W) outputted from a receiving amplifier (5) and a received wave (W) exceeds 0V, a received wave (W) and the square wave (K) of this period are outputted.

[0023] The received wave (W) outputted from a receiving amplifier (5) on the other hand in the 2nd comparison circuit (8) as shown in drawing 2 (a), When the reference-voltage value Vth outputted from circuit generating reference voltage (10) is compared and a received wave (W) reaches the reference-voltage value Vth, a receiving decision signal is transmitted, and this performs the receipt-of-letter judging of a supersonic wave. Thus, since the amplitude difference of adjacent waves performs a receipt-of-letter judging by the wave for the large first portion (this embodiment the 2nd wave), a receipt-of-letter judging can always be performed on the basis of the same wave (the 2nd wave).

[0024] In latch circuitry (9), as shown in drawing 2 (c), when a receiving decision signal is transmitted from the 2nd comparison circuit (8), a gate pulse (G) is outputted.

[0025] In a gate circuit (11), as shown in drawing 2 (d), when a gate pulse (G) is outputted from latch circuitry (9), the square wave (K) outputted from the 1st comparison circuit (7) is passed, and a next square wave (K) is extracted the event of a received wave (W) reaching the reference-voltage value Vth.

[0026] As shown [n ** counter (12)] in drawing 2 (e), when the square wave (K) which has passed the gate circuit (11) is counted and the predetermined wave-number (two waves) count of these square waves (K) is carried out, That is, after starting a count, the time of the square wave (K) of eye three waves rising is made into ultrasonic reaching timing

timing, and an ultrasonic attainment impulse wave (J) is outputted. Thus, since (Z) is made into ultrasonic reaching timing at the zero cross event of a peak swing wave (Wm) There is almost no floating of (Z) at the zero cross event by interference of the reflected wave of the last determination, ambient noise, etc., and the received wave (W) reaching timing for propagation time difference determination can be specified with sufficient accuracy.

[0027] The rest finds the time from the event of a supersonic wave being transmitted using a clock wave etc. to receiving reaching timing as propagation time tau of the supersonic wave of a direction of easy flow.

[0028] After [in this way,] finding the propagation time tau of the supersonic wave of a direction of easy flow It changes so that a drive pulse generation circuit (4), and the ultrasonic transducer by the side of the lower stream (3), the ultrasonic transducer by the side of the upstream (2) and a receiving amplifier (5) may be connected by actuation of a switching circuit (6), and it asks for ultrasonic propagation time tau' of a reverse direction like ****. Since the propagation time difference (tau-tau') which changes according to the flow velocity has arisen, the propagation time tau of the supersonic wave of these directions of easy flow and a reverse direction and tau' search for the flow velocity of the fluid based on this propagation time difference (tau-tau'), and calculate the fluid flow if needed further.

[0029] In addition, in this embodiment, although the 2nd wave (W2) of the received wave (W) was used for the receipt-of-letter judging, you may use the wave for the first portion of others of a received wave (W).

[0030] Moreover, although (Z) was made into ultrasonic reaching timing at the zero cross event of the peak swing wave (Wm) of a received wave (W), it is good also considering the zero cross event of the wave near the peak swing wave (Wm) as ultrasonic reaching timing.

[0031] Moreover, although the predetermined wave number counted in n ** counter (12) was made into two waves, you may change according to a received wave's (W) own characteristic and the wave for the first portion of the received wave (W) used for a receipt-of-letter judging. For example, what is necessary is just to let the predetermined wave number to count be n wave, if the wave number from the wave used for the receipt-of-letter judging in a received wave (W) to a peak swing wave or the wave of the neighborhood is n wave.

time of flight

[0032] Moreover, although propagation time of the supersonic wave was made into the time from the event of a supersonic wave being transmitted to ultrasonic reaching timing, it is good also as time of the event of subtracting or adding predetermined time to ultrasonic reaching timing from the event of a supersonic wave being transmitted. For example, it is good by subtracting predetermined time from received wave (W) reaching timing also considering the time of the event of the supersonic wave being first received from the event of asking for the event of a supersonic wave being received first, and a supersonic wave being transmitted as propagation time of a supersonic wave.

[0033] Moreover, are not limited to the above-mentioned circuit configuration, and by specifying the event of the wave for the first portion of a received wave (W) reaching a reference value, perform a receipt-of-letter judging and a predetermined wave number is counted from the reference-value attainment event of the received wave (W). As long as it makes the zero cross event of the peak swing wave after the predetermined wave-

number count (Wm), or the wave of the neighborhood into the ultrasonic reaching timing for propagation time difference determination, you may be other circuit configurations.
[0034]
[Effect of the Invention] Since the amplitude difference of the adjacent waves in a received wave performs a receipt-of-letter judging by the wave for the large first portion according to invention concerning Claim 1, a receipt-of-letter judging can always be performed on the basis of the same wave. And further since the zero cross event of the peak swing wave after a predetermined wave-number count or the wave of the neighborhood is made into ultrasonic reaching timing from the reference-value attainment event of a received wave It becomes possible for there to be almost no floating at the zero cross event by interference of the reflected wave of the last determination, ambient noise, etc., and to be able to specify the ultrasonic reaching timing for propagation time difference determination with sufficient accuracy, as a result to secure sufficient accuracy of measurement.
[0035] According to invention concerning Claim 2, the ultrasonic flow-velocity measuring method according to claim 1 is certainly [simply and] realizable.

[Translation done.]

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PATENT AND
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35 U.S.C. 112 2nd paragraph

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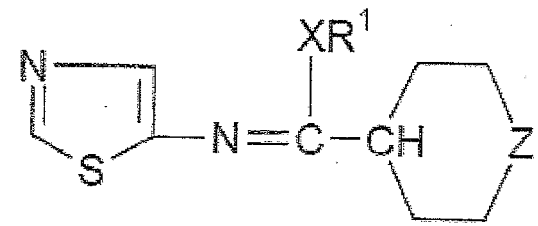
Example 7B: Variable Recited in Chemical Formula is Defined in Specification

Claim 1. A compound having Formula 1



wherein R1 is methyl or phenyl and X is selected from oxygen and sulfur.

Claim 1 does not define variable "Z". In this example, assume that the specification provides that "Z" is any appropriate linker for the two methylene moieties adjacent to Z.

In this example, no rejection under 35 U.S.C 112 2nd paragraph would be warranted.